LIMITED

ECAFE/TRANS/Sub.1/1
24 December 1952

ORIGINAL: ENGLISH

ECONOMIC COMMISSION FOR ASIA AND THE FAR EAST

INLAND TRANSPORT COMMITTEE

Railway Sub-Committee
First Session
14-17 January 1953
Bandung, Indonesia

* IMPROVED METHODS OF TRACK MAINTENANCE

Preliminary Report
by the Executive Secretary

Table of Contents

		Page
I.	INTRODUCTION	2
II.	RAILWAY TRACK AND ITS CARE	4
	a. Formation (embankment and cutting)	5
	b. (i) Sub-ballast; (ii) Ballast	7
	c. Sleepers and fittings	9
	d. Rails and fastening	11
	e. Turn-outs	13
	f. Curves	14
III.	GAUGE	16
IV.	MAINTENANCE	18
	(i) Track maintenance	18
	(ii) Creep	19
	(iii) Organization of maintenance gangs	22
	(iv) Railway signs	26
V.	MODERN EQUIPMENT	28
VI.	GENERAL REMARKS AND RECOMMENDATIONS	32

INDIANA UNIVERSITY
MAR 23 1953
LIBRARY

* This document has been reproduced in New York from the original issued at Bangkok.

I. INTRODUCTION

The Economic Commission for Asia and the Far East at its fifth session held at Singapore in 1949 approved the report of the Meeting of Inland Transport Experts (E/CN.11/204) which, while including the following item under Railways, desired that an expert examination should be undertaken of :

1. RAILWAYS

c) Improved methods of repair and maintenance.

This subject could not be pursued due to staff limitations. In view, however, of its great importance it was included in the work programme as project No. 31-04 in Group 2 (E/CN.11/342, Annual Report of the Eighth Session to ECOSOC) and was again included in the Secretariat Programme of Work and Priorities for 1953 as No. 43-02 in Group 2 (E/CN.11/355) under the title "Improved Methods of Track Construction and Maintenance." As it has not been possible to make much headway during 1952 in the study of this problem the following preliminary report has been prepared to give a general appreciation of the nature of the problem and to indicate the possible methods of tackling it.

GENERAL REMARKS

It is a fact that during the past 100 years great contributions have been made by engineers to the progress and development of railways. These engineers have supervised the design and construction of the fairly vast railway networks that are now serving so well the countries of the region. When the railway expansion work slowed down, they turned their attention, skill and energy to the engineering problems involved in the maintenance of railways. During all these years, however, the civil engineers had, so to say, a perpetual warfare with the mechanical engineers who were responsible for continually increasing axle loads of locomotives, and with the operating officers for increasing speeds. The struggle was to improve the railway track and bridges so as to handle ever heavier and faster loads. Every round of improvement of track was followed by still heavier locomotives and still higher speed demands.

/With the

With the outbreak of the Second World War resulting in out of proportion and unprecedented increase in traffic, with track renewal programme being thrown out of gear, due to great difficulties in getting supplies of permanent way materials and diversion of the available stock for emergent war works, the track, generally speaking, continued to deteriorate year by year. By the time hostilities ceased it had, more or less, reached a dangerous situation in most of the countries of the region. Steps, however, were taken by the countries to attend to their immediate renewal needs on austerity basis. But there was again "a set-back" in India and Pakistan due to partition, and in Burma, Cambodia, Federation of Malaya and Viet-Nam, due to disturbed internal conditions.

It will be admitted that a continuing level of activity is essential for the efficient upkeep of the track, and that efficiency of maintenance goes down and the cost of maintenance goes up with a "stop-and-go" policy in maintenance. Furthermore, once arrears of maintenance are permitted to accrue it becomes extremely difficult to catch up in future years the accumulated total of deferred maintenance. But the circumstances leading up to the back-lag in maintenance were beyond the control of the countries.

Track maintenance is the biggest single item in the expenditure on railways, and during post-war years its ratio to the total revenue has appreciably increased. The relatively greater increase in the cost of labour and material as compared to the increase in rates and fares is the chief cause of the higher ratio. As a matter of fact the pyramidal costs of everything connected with railway operation, combined with the decreases in earnings due to competition with other forms of transportation and with rate and fare increases vehemently resisted by the general public, the problem boils down to how much a railway can save in its operational costs rather than how much more it can earn. The experience of the past few years has revealed that railways have to meet mounting demand, by increased capacity and higher efficiency all round, at lower expenditure. It is therefore only the combination of - increasing volume of business, greater operating efficiency and lower revenue expenditure - that can counterbalance rises in wages, cost

/of material

of material and fuels.

In terms of expenditure on track the situation has added immeasurably to the weight of responsibility of the civil engineer. He is to struggle harder than ever before to reduce cost of maintenance and to obtain more life from materials. He has also to strive to improve track standards and maintenance to deal with heavier and faster and more frequent services. In short, the civil engineer is to aim at the best construction and maintenance standards and methods to meet ever growing demands of more and faster trains for maximum passenger speeds with comfort and minimum overall time schedules at lesser costs.

Improved and modern track tools and machines are available in the market. They have been successfully used on American and European railways for track maintenance. This has also placed on the railway engineers of the region onerous and difficult responsibility in selecting the best and most suitable of the above for their countries. The present day spiral tendency of cost of labour and materials makes it more imperative for them to choose equipment cautiously and to use them wisely. They should, however, take advantage of what science has given them, through invention, things better and more efficient to use in places of old appliances giving greater economies.

To shoulder such a responsibility, however, it is essential that they should have intimate knowledge and experience of the working of new tools and machines.

II. RAILWAY TRACK AND ITS CARE

The railway track is made up of :

a. Formation (embankment or cutting)
b. (i) Sub-ballast; (ii) Ballast
c. Sleepers and fittings
d. Rails and fastenings
e. Points and crossings
f. Curves

/a. Formation

a. Formation

It may be either an embankment or a cutting. The embankment is made up by filling, to the required profile, with due allowance for settlement, with any suitable material, available in or near the locality, or by digging from nearby ground, earth, sand, etc.

Regarding the dimensions of the bank, no hard and fast rules can be laid down, but taking various general conditions into account, each country has laid down the standard dimensions to be followed. Modifications to these dimensions are made as and when needed to suit local conditions.

In this connection, it is of paramount importance to bear in mind that, for a good track, it is not enough to have ample ballast, heavy rails and sound sleepers with good fastenings; it is essential to have a sound and stable formation - the very foundation of track structure.

Much progress has not been made in most of the countries of the region in scientifically dealing with bad and unstable portions of track formations. Some countries, however, have tried various modern methods with varying degrees of success.

In American and European countries, since about 1920 the science of soil mechanics has developed rapidly and has been employed extensively in the construction of water dams and highways and, in later years, in airports to decrease the deformation of soil in the finished structure. More recently this science has been adopted in its various aspects in the construction and maintenance of railway embankments - especially the high banks. It is an accepted principle that cohesion and bearing value of earth materials are lowered with moisture progressively as they near the saturation point. Other conditions which contribute to make the formation unstable are: bank made up of unsuitable materials, having insufficient supporting value to sustain the loads imposed upon them; filling on sloping ground or rock without first removing vegetation and benching it to secure a bond between the natural ground and the filling; non-provision of drainage; inadequate subgrade drainage; cutting through unstable strata; and embankment built on yielding ground and last but not the least, faulty construction. There are other

/factors too

factors too, such as heavy rainfall, flooding, water pockets, high water-table, slides, breaches, erosions, porcupine and field rat holes etc., which may make the formation unstable.

Some of the methods adopted to deal with unstable formation are as follows: cutting the shoulders of the embankment and back filling with porous materials; boring vertical holes down through embankment to porous strata underlying the natural ground; installation of adequate sub-drainage system; construction of deep and wide side drains and ditches tc lower water tables; driving of poles or piles in the shoulders of embankment; forcing of cement grout into unstable areas; placing of reinforced concrete or wood matting on top of the bank; and providing carpet of stone boulders, brick-bats or ashes etc. Other methods adopted include improvement to drainage of the area, rebuilding of the bank with more stable soil, placing additional earth-work along the slopes of the bank to add stability, flattening of slopes, boring of holes, and either back filling with sand or dynamiting.

Stabilizing the formation by grouting with grout slurries 1:3 to 1:32 cement and sand has now past the experimental stage. The grouting has been very successful in fillings. It has the following advantages:

1. When voids are filled, water is kept out thereby increasing soil strength. The large amount of grout, as often accepted, fills void spaces.
2. Sand and cement in the grout restore cohesion and friction in the soil and along the slips.
3. Compactness of soil is achieved if grouting is done under pressure - it also increases density and thereby stability.

Asphalt emulsion is also frequently used in slurries in quantities 0.1 to 0.2 gallons per cubic foot of sand.

Wood mats. Sub-ballast mats of treated timber planks comprising of solid transverse course overlaid with open longitudinal courses with broken butt end joints have been successfully laid on unstable bank as high as 30 feet and in as long stretches as 1,400 feet.

Concrete slabs. Precast and cast-in-situ reinforced concrete slabs have been used where the traffic is very heavy. On one American railway

/8,560 feet

8,560 feet of slab in length was cast at site over an unstable cutting for a single line track about thirty years ago and it is still standing up well. Slabs are generally 12 inches to 15 inches in thickness with either wire mesh reinforcement or top and bottom steel bars reinforcement.

Sand pile method. Short tapered piles are driven along the bank at frequent intervals and then withdrawn backfilling with sand. This also helps in releasing entrapped water, improving drainage and increasing the bearing power of the formation.

Another method which has been tried with success is to drive a series of holes along the bank using long hard points and mechanical hammer. At the bottom of the holes thus formed, small charges of dynamite are placed and detonated causing small pockets which are later filled with sand under pressure. Dynamiting also helps in stabilizing the soil by settling where the bank has become porous.

b. (i) Sub-ballast

Provision of sub-ballast on American railways is quite popular, though some railways of the region also have resorted to the provision of sub-ballast under the ballast at places where the bank gives trouble. Although modern methods provide maximum compactness of the formation, it is considered good practice to provide a separating blanket of pervious material 6 in. to 10 in. in thickness between the ballast and formation, such as crushed stone, slag, prepared gravel, ballast screenings, quarry pit refuse, cinders or sand, to prevent intermingling of ballast and earth, to distribute loads to the formation and to provide porous material for the escape of water and moisture. This also effects savings in ballast, as experience has shown that in course of time, ballast sinks and gets mixed up with earth and when wetted, gets clogged and forms hard surface thus reducing effective depth of ballast and impeding drainage. This necessitates either provision of additional ballast or re-using the same after breaking the clods and screening the ballast which process is not only expensive it affects free flow of traffic due to blocks and speed restrictions.

/b. (ii) Ballast

b. (ii) Ballast

Ballast in the track is used to :

(a) Provide a firm and even bearing for the sleepers and to distribute the load as evenly as possible over the formation;

(b) Provide adequate drainage of the track structure and thus prevent "puddling" or "pumping" track;

(c) Fill space between sleepers and to form shoulders between the ends of sleepers and toe of ballast slope in order to hold sleepers in their proper places and thus keep the track in right alignment;

(d) Assist in preventing growth of vegetation within thelimits of the track;

(e) Facilitate track work in wet weather;

(f) Provide a means whereby the track can be readily restored to its proper level and alignment;

(g) Provide a resilient and elastic support for the track and to afford a means for elimination or reduction of capillary action.

The ballast should be hard, heavy, durable, angular and clean, and free from dust, dirt and vegetation. It should weather well and resist abrasion.

The size of ballast used on various railways varies from 3/4 in. to 1½ in. Smaller size ballast is preferred for points and crossings.

The depth and width of ballast depends on the gauge, axle load, and density of traffic. It also varies for main lines, branch lines (important and non-important) loops and sidings. In the railways in the region the thickness of ballast under sleepers varies from 2 in. to 8 in., while on American railways up to 18 in. thickness of ballast is being used.

The frequency of ballasting, resurfacing, and ballast cleaning or skeletonizing (removing of ballast and renewing foul ballast with clean ballast) will depend on the condition of ballast, and sleepers riding qualities of track, axle load, traffic density and speed of trains.

/c. Sleepers

c. Sleepers and fittings

Wooden, iron, steel and on very small scale, reinforced concrete sleepers are being used in the track. The advantages of using wooden sleepers are obvious and, therefore, wherever available at reasonable cost, railways prefer to use wooden sleepers over other types. Regarding iron and steel sleepers, more than 2,500 different designs have been originated and patented and used with varying degrees of success. C.S.T.9 and steel trough sleepers are commonly used in India and Pakistan. Reinforced concrete sleepers, however, are still in an experimental stage, though French Railways are trying to adopt them.

For points and crossings, bridges, ash pits and drop pits etc., wooden sleepers (both cross and longitudinal) are extensively used. In recent years, however, due to shortage of wooden sleepers, some countries have started using steel trough crossing sleepers.

As far as is known, about 55 per cent of the total number of sleepers in India and Pakistan are still wooden sleepers. On a global basis, however, well over 90 per cent of sleepers in use are reported to be of wood.

Dimensions of wooden sleepers. Since the very beginning the subject of dimensions of sleepers has received considerable attention. Fixing of the length, and to some extent, the width and breadth of sleepers is more or less arbitrary, as owing to many variables involved, their dimensions cannot be calculated with the exactitude of a structural member of, say, a bridge or a roof truss. But the main factors which are taken into account for fixing the dimensions are the gauge, axle load, speed, strength of timber, its average condition in the track, condition of the formation, weather condition, etc. Most of the countries have standardized railway sleepers. It is, however, felt that the longer the sleeper the better it is, as it provides greater support, and reduces the amount of wasted ballast at the centre of the track, because longer sleepers permit longer tamping areas inside the rails without producing centre bound track. When well tracked the sleepers give more stable resistance to the forces that tend to distort line and surface. And there is no increased cost of labour in laying them. Therefore, compared

./to the

to the additional expense for longer sleepers, the advantages are, reduced labour and maintenance and operating economy, and far smoother riding conditions at higher speeds.

Quality of wooden sleepers is judged by their resistance to wear and decay. There are about 27 kinds of wooden sleepers, both hard and soft, which are at present in use in the track.

The density of sleepers per rail varies from n to n + 5 in the railways of the region, while in America as many as n + 11 per rail are adopted.

There being greater scarcity of hard wood sleepers, it became necessary for railways to adopt soft wood sleepers. Soft wood sleepers being prone to quicker decay, it was found necessary to adopt wood preserving methods to prolong their life in the track. Railways were the first to start using creosote to preserve soft wood sleepers. In more advanced countries, the wood preserving industry has reached the age of maturity and the use of treated sleepers has become fairly widespread in the railways. According to an American railway estimate, the life of a soft wood sleeper is increased from about seven years (untreated) to about twentysix years by treatment. Chemical treatment of sleepers is, therefore, not only economical, but it also reduces drain on forest resources. The benefits derived from treating sleepers with chemicals is of indeterminate magnitude as the use of wooden sleepers in the track with its natural properties of resiliency provides comfortable travel. Wooden sleepers also have low conductivity, high strength per unit of weight, lightness and ease of handling, widespread availability and comparatively moderate cost.

Recent studies have revealed that much of the trouble in treated sleepers was due to adzing and spiking after the sleepers were treated, thus exposing the untreated interior to attacks by decay producing organism. Now adzing and boring is done prior to treatment.

Seasoning of timber is done either by air seasoning, kiln drying or vapour drying. When timber is dried rapidly, case hardening occurs, forming an outer shell. It is unfavourable as it tends to hold moisture inside

/causing the

causing the wood to crack and split as seasoning progresses. These internal cracks follow the medullary rays of the wood fibre and are termed as honeycombing or hollow horning.

For treatment of wood, chemicals of various kinds are used to make the timbers poisonous or repellent to fungi, insects or marine borers. To prolong the life of sleepers the toxic should penetrate deep, and should not harm the wood or any fittings used with the sleepers. The chemical used should be safe to handle, should be economical and available in quantities. Coal-tar and zinc chloride are extensively used. Since 1936, however, increased interest has been displayed in salts other than zinc chloride, such as, Pentachlorophenol, Chromated zinc chloride, copper napthenate, zinc-meta-arsenite and wolman salts.

The most recent development in the dilution of creosote for preservative purposes is the addition of petroleum, in which the proportions of the constituent oils are varied to correspond to the species of wood.

In the above treatment, the pressure treatment gives longer life to wood than non-pressure treatment.

The supply of wood in the region for railway sleepers falls short of the requirements. In 1950, Japan had about 34 per cent of its requirements, India 60 per cent, while Burma, Thailand, Federation of Malaya, Indonesia, North Borneo and Philippines could meet their requirements, provided other difficulties, including transport, were surmounted; but the latter railways represent only a small percentage of the total railway network in the region. If, however, the cutting, treating and supplying of railway sleepers is properly organized in the region, the present difficult situation would considerably ease.

d. Rails and fastenings

Various types of rails are being used by different railways in the world. There are flat-footed, double-headed and bull-headed. Flat-footed rails, however, have gained more popularity and are more extensively used.

Since the first introduction of rails for railway track, their

/weight has

weight has gradually increased with the increase in the axle load of locomotives, speed of trains and density of traffic. In this region, India is using as heavy as 115 lbs. R.B.S. flat-footed rails, while in America in recent years three sections, 115 lbs. RE, 132 lbs. RE and 133 lbs. RE, have been introduced. These are the results of very intensive study by the research staff of the Association of American Railroads. It is claimed that the sections adopted produce better distribution of stresses.

The weakest portion of the rail is the joint. Different methods have been adopted in various countries to deal with the "joint" problem, such as, improved types of fish plates, bolts, joint bearing plates, provision of better support at the joint, reconditioning of end worn rails and welding of joints.

Through long experience over years, no feature of track construction has caused more concern to maintenance staff than rail joints. As stated above, this forms the weakest part of the track structure. The combination of yielding foundations, successive blows of passing wheels, wave motion, contraction and expansion in rails due to temperature changes, side thrusts from wheel flanges, cause severe strain on rail joints. It is a principal source of expense in track maintenance. If the joints are not properly maintained, the rail ends are subjected to severe and even abnormal stresses causing permanent injury to rail ends.

Reconditioning of rail ends is generally done by :

1. Preheating and reforming with dies in a heavy press;
2. Rebuilding by preheating and welding additional metal on worn portion;
3. Flame straightening; and
4. As a temporary measure, by applying metal insets or joint shims.

Welding of rails. Continuous welding of rails had been a standard practice in tramway tracks in some countries, but it was not until after about 1925 that welding of joints was adopted by some railways. Since then it has been gaining wide popularity in many countries. Very few weld

/failures have

failures have been reported - more in tunnels than in the open. The savings in maintenance, as claimed by some railways, is as much as 30 per cent of their maintenance charges per mile. It is now a standard practice in some countries.

Continuous welding is intended primarily to present an unbroken section of rail, eliminating battered and chipped rail ends, and consequently prolonging service life, building a stronger and more permanent track structure, providing a smoother track with lesser shock to rolling stock, prolonging life of sleepers formerly used under joints, improving signal circuit operation and eliminating rail bondage.

During the pre-war period, some railways of the region started welding of rails initially as an experimental measure, but before they could adopt it on a bigger scale the war broke out and further progress was halted. Deli Railway in Sumatra, however, has progressed well in welding and now about 75 per cent of its track has 40-metre long welded rails.

Rail failures. Rail failures occur owing to:

1. Transverse defects, i.e., transverse fissures, compound fissures.
2. Horizontal split heads.
3. Vertical split heads.
4. Piped rails.
5. Crushed heads.
6. Split webs.
7. Broken base.
8. Square or angular breaks.
9. Damaged rails.

In America and Europe, apparatus have been developed to detect faults and fissures in rails for their immediate replacements.

(e) Turn-outs. There are:

1. Main line turn-outs. Some countries have-
   a) High speed turn-outs; and
   b) Main line or common turn-outs.

/ 2. Yard or

2. Yard or low-speed turn-outs.

For strength and longevity, extended use of specially manufactured steel, strongly constructed, turn-outs are being used to to deal with high-speed trains.

As a general rule, wooden sleepers are used under points and crossings, but due to shortage of wooden sleepers some countries, including India and Pakistan, have been using steel trough sleepers.

Greater attention and care has to be given to the provision of adequate quantity of good quality of ballast; drainage and packing, for their proper maintenance, to ensure safety of train operation and to provide smooth riding.

(f) Curves. In a good railway alignment there should be as few curves as possible and these too as flat as economically feasible.

Curves have the following objectionable features:

1. Increase wear and tear on track and equipment.
2. Necessitate and increase in the tractive force or require a reduction in the train tonnage unless compensated by changes in grade.
3. Require greater care in construction and additional attention in maintenance and hence increased maintenance cost.
4. Sharp curves frequently prevent the use of heavier locomotives.
5. Tend to increase the running time of trains by imposition of speed restrictions.
6. Interfere with and reduce extent of clear view.
7. May increase the cost of signal facilities.
8. When in the yard, they may require longer loops because of the undesirability of locating turn-outs on the outside of the curves.
9. Frequently involve increased expenditure for bridge construction.
10. Great obstacle to sustained high train speeds.

It is essential that as a policy all curves - particularly on the main line - should be gradually transitioned to a programme. Transitioned

/curves have

curves have the following advantages:

1. They provide gradual transition between the curve and the tangent or between two connecting curves.

2. They provide a limited distance in which the vertical elevation of the two rails is changed uniformally to provide a centripetal force with which to counteract the centrifugal thrust of a moving train. The maximum elevation of the outer rail of a curve generally determines the length of the spiral, because the vertical transition is made at a constant rate.

/III. GAUGE

III. GAUGE

Railway gauges

The following are the gauges adopted by various railways in the world:

5'6", 5'3", 5'0", 4'8 1/2", 3'6", metre, 2'6", 2'2" and 2'0".

In addition, a few railways have also adopted the gauges mentioned below. These gauges, however, represent only short lengths of track:

5'5 3/4", 4'7 1/2", 3'5 1/4", 3'0" and 2'7 1/2".

The approximate lengths and gauges of the railways in the region are as indicated below.

/ Lengths of Railways

Lengths of Railways in kilometres and in miles[1]

Country	Gauges					Total
	5'6"	4'8½"	3'6"	Metre	2'6" & 2'0"	
Burma	-	-	-	2,738 km 1,771 mi	-	2,738 km 1,771 mi
Cambodia and Viet-Nam	-	-	-	3,007 km 1,640 mi	-	3,007 km 1,640 mi
China[2]	-	47,580 km 18,760 mi	-	-	-	47,580 km 18,760 mi
Ceylon	1,302 km 809 mi	-	-	-	140 km 87 mi	1,442 km 896 mi
India	29,525 km 16,555 mi	-	-	27,827 km 15,159 mi	4,761 km 4,110 mi	62,113 km 35,824 mi
Indonesia	-	-	7,549 km 3,039 mi[3]	-	-	7,549 km 3,039 mi
Japan	-	875 km 480 mi	22,138 km 12,257 mi	-	-	23,013 km 12,737 mi
Korea	-	3,380 km 2,101 mi	-	-	-	3,380 km 2,101 mi
Malaya (Federation of)	-	-	-	1,438 km 894 mi	-	1,438 km 894 mi
North Borneo	-	-	-	187 km 116 mi	-	187 km 116 mi
Pakistan	8,352 km 5,230 mi	-	-	2,286 km 1,421 mi	1,022 km 759 mi	11,660 km 7,410 mi
Philippines	-	-	1,046 km 843 mi	-	-	1,046 km 843 mi
Thailand	-	-	-	3,270 km 2,032 mi	-	3,270 km 2,032 mi
Total	39,179 km 22,594 mi	46,255 km 21,341 mi	36,313 km 16,139 mi	40,753 km 23,033 mi	5,923 km 4,956 mi	168,423 km 88,063 mi

1/ Mileages of railways taken from Directory of Railway Officials and Year Book 1950-51.
2/ Includes 3,040 miles and 5,380 km of other gauges.
3/ Includes 695 miles of other gauges.

IV. MAINTENANCE

(i) Track maintenance

As the railway track is not a fixed structure, it becomes necessary that continuous attention should be paid to it to keep it in level and in alignment. Various methods of track maintenance have been adopted by different countries and very extensive research and investigations have been made in methods of track maintenance. Generally speaking, track maintenance includes:

1. Picking up slacks;
2. Levelling and gauging;
3. Through packing;
4. Thorough through packing.

In addition, the track receives complete renovation when track renewal work, such as, changing of sleepers, rails, or both sleepers and rails is done. The track maintenance also includes other work, such as making up the bank to the proper profile, weeding of ballast, improving drainage, and greasing of fish plates (usually once a year, before hot weather), etc. All the countries of the region have laid down detailed instructions as to how the track is to be maintained. Generally the work of through packing and thorough through packing is programmed, and the progress entered in a chart kept with each gang by the supervisory staff.

Regarding thorough through packing, which includes repairs and proper sloping of the formation, removing and screening of the entire ballast, making up the shortage in ballast, changing bad sleepers, fittings and worn-out rails, and packing the track and boxing; there are two schools of thought. One fells that a solid, well-consolidated bed of a track should not be disturbed, while the other is of the opinion that periodical complete overhaul is necessary. Complete overhaul of track was tried in India during 1938 and 1939, but the work was suspended on the outbreak of the war in 1939. The obvious disadvantage of complete overhaul is that it necessitates blocks and subsequent speed restrictions for fairly long periods with adverse repercussions on train operations.

/The method ...

The method of track maintenance in most of the countries of the region is still as of the old and the tools used for maintenance have also remained more or less unchanged. In more advanced countries, like America and Europe, there has been a growing appreciation of the value of work equipment and power tools, both in maintenance and construction of track, and today it would not be wrong to assert that they have machines, power tools and appliances for every class and phase of work connected with the track. These countries, by their adoption of modern methods, have not only saved labour, lowered unit costs, increased production and taken the drudgery out of many arduous hand tasks, but they have also increased the personal safety of the workmen. Furthermore, they have effectively reduced to the minimum restrictions and interference to traffic operation. Unquestionably, in these countries, the introduction of the machines has been greatly responsible in helping to keep costs of construction and maintenance of railway track down, in the face of rising wages and prices.

Simultaneously, with improvement in power equipment and development of new mechanical appliances, the above countries have also improved in design, metallurgy and methods of manufacture, giving greater strength and durability, and also reducing weight of hand tools used for maintenance works, as for small out-of-the-way jobs, the use of hand tools is still indispensable. On the other hand, power plants and other modern equipment are found more useful for specific jobs, e.g., laying new railway lines, re-laying, re-sleepering, complete track renewal and remodelling of big Railway yards etc.

(ii) Creep

The causes of creep are:

1. Impact of the wheels on the ends of the receiving rails, tending to drive the rails forward;

2. The wave motion of the rails ahead of the advancing wheels, the tendency of this motion being to lift the track from its bed and force it forward in the direction of motion; and

/3. Application of

3. Application of brakes to moving train wheels, which retards the motion of the train by increasing the friction between the wheels and the rails. This latter action tends to drag the rails forward. Such drag is further increased in descending grades, thus accounting for increased tendency of the rails to creep in the direction of traffic and downgrades.

In addition, the following are the tendencies which tend to promote creep:

1. Heavy tonnage with traffic preponderantly in one direction;
2. Insufficient allowance at rail joints for expansion and contraction with changes of temperature;
3. Inadequate or insufficient ballast in the track;
4. Poor condition of sleepers and fittings, viz. loose spikes or coaching screws;
5. Wide sleeper spacing;
6. Poor drainage of the track;
7. Loose bolts;
8. Descending grades.
9. Train braking (at approaches to stations, and places where speed restrictions have been imposed).

The usual places where creep generally occurs most are:

1. Portions of track on poor formation, unless adequately dealt with;
2. Downgrades;
3. Approaches to stations - particularly watering stations;
4. Bridges with permanent speed restrictions over them;
5. Sharp curves;
6. Places where speed restrictions have been in force for long periods.

/Creep sometimes

Creep sometimes manifests itself in seemingly strange and unpredictable ways, but primarily depends upon the vagaries of traffic and traffic conditions. Rails have been known to creep in the direction of upgrades as well as to creep first one way and then the other way on level track under trains moving in both directions. Also one rail of a track may creep faster than the other, or one rail may creep and the other may not creep at all, or two rails may creep in opposite directions.

Again, rails have been known not to creep for long periods and then suddenly start creeping.

The following are the usual evidences of rail creeping:

1. Closing of rail joints in the direction of creep;
2. Opening of joints on the opposite side of the place where creep starts;
3. Marks begin to show on rail flanges where spike heads scrape the rails as they slide.
4. The sleepers get out of square, forcing ballast ahead of them and forming small heaps, leaving hollows behind them;
5. If creep is either not checked or pulled back, points and crossings are pushed out of alignment;
6. In extreme cases, the track may buckle.

Remedy

Creep should be pulled back and measures taken to hold the rails effectively in their position by rail anchors. Rail anchors are appliances designed to resist, or entirely check, longitudinal movement of rails under traffic and thereby proper expansion allowance at rail joints for temperature changes are maintained. Rail anchors try to hold the rail in a fixed position in relation to sleepers. Proper anchorage should be provided for tracks in the yards and over humps, as creep would distrub the alignment and gauge of points and crossings, which may cause serious consequences. Anchorage of rails on approaches to bridges is also essential.

/There is

There is no hard and fast rule according to which the number of anchors per rail length can be fixed. It is a matter of judgment and experimentation.

A fairly large number of anticreep anchors have been originated and patented and used with varying degrees of effectiveness, such as, Yates, Fair, Weston, Double U, Woodings True Temper, Gantier, etc. etc. Also, special joint sleepers and chairs, and binding of two or more sleepers with tie bars have been tried.

(iii) Organization of maintenance gangs

Except for special works, the usual system adopted in the countries of the region is that the railway is divided into small sections of 3 to 6 miles and each section of the track is under the charge of a gang for the purpose of maintenance. The gang consists of a mate in charge of the gang, a key-man who is required to patrol the line for the purpose of finding out weak spots and also tightening up small fittings, and the gangmen. The strength of the gangs depends on the gauge, whether it is a mainline, branchline (important or unimportant), or sidings. Other factors which are taken into consideration for fixing the strength of a gang are axleload, density of traffic, speed, local conditions, quality of men locally available, type of formation (stable or unstable), rainfall in the area, and condition and quality of materials of the track. The number of the men provided varies from .25 to 3 men per mile. Additional men in the gang are allowed for the yard points and crossings, and bridges and tunnels. The supervisory staff of a gang are sub-inspector, inspector and engineer. To save the gang walking long distances to reach to their work, most of the railways provide gang huts more or less in the middle of the section of each gang. Each gang is provided with a set of tools. In the light of the experience gained each country of the region has fixed the scale of gangmen per mile for various kinds and types of track and their maintenance tools.

/Any special

Any special work, such as, picking up bad section of the track due to unforeseen reasons like floods etc., and for re-sleepering, relaying or track renewals, pulling back creep, re-aligning curves, overtaking arrears in maintenance etc., is done by special gangs appointed for the purpose. Some railways of the region have tried as an experimental measure longer lengths with bigger strength of gangs, but unless they are provided with means of transportation to reach their work, this will result in the gangs' time being lost in walking up to the place of work. The output may also be less, as by the time the gang reaches the place of work, the men would be fairly tired. It has been known that individual gangmen have been using bicycles for coming to and going from their work, but this is purely individual arrangement, and railway administrations so far have not provided this means of transportation to their gangmen.

In more advanced countries, gangs with greater strength and longer sections with means of transportation and power tools have been employed with advantage and economies. This system has the advantage of saving time for the gangmen to reach the place of their work, greater uniformity of work and better track maintenance. The type of transport provided for these gangs depends on the locality in which the gangs are working. Where parallel roads exist, trucks have been provided, otherwise the following means of transport are employed:

1) Cycles. This is provided where the distance is not too long. It has the advantage of flexibility and economy.

2) Railcars. These can carry gangs with their power tools for longer distances. They can also be used for taking the gang to places, long distances away, in case of emergency and for inspection of track, for patrolling of the line in bad weather, and for other miscellaneous work, such as, removal of earth, bringing ashes, etc. The only disadvantage in railcars is that while running on the track it has got to observe safety regulations which sometimes means delay, particularly on busy sections. They are also fairly expensive in running and maintenance costs.

/In America

In America to-day more than fifty thousand such cars are in service, daily travelling more than one-half million miles.

Some of the gangs with long lengths are also provided with portable telephones. The secret of success, to a large extent, in the above system as also in all other systems, is the quality of supervision. The supervisory staff should have thorough knowledge of the work, as men working under their direction will respect their ability because of the knowledge or the amount of "know-how" they possess.

In America, one of the railways has established district gangs on a large scale and has eliminated most of the section gangs. These gangs handle all regular maintenance work in their territory. The gang foreman usually assigns small portions of track of the district to small formations. The gang, foreman is, however, responsible for the whole district. The gang generally consists of one gang foreman, one assistant foreman, truck driver and ten/fifteen gang men. Each gang has transportation and inspection type motor trolly for track patrolling. Where transportation, by truck, is not feasible, the gang is provided with a railcar. A section of the splitted gang works under the charge of an assistant foreman, and one to three men are assigned to duties of patrolling the track and taking care of ordinary, light jobs, while the remaining gang, under the gang foreman himself, does special and specific jobs. Each gang is equipped with a fairly complete complement of power tools. The length of track under the charge of each gang is about 33 miles.

This system, as also the introduction of mechanical tools and power plants for permanent way maintenance in the more advanced countries, has been the result of evolution. As far as material progress is concerned, there is nothing certain or automatic about this process. Results are dependent on the thought, skill and the amount of work and as time passes and efforts continue to be made, better results are achieved, as there is no end to the road. No matter how much progress towards greater efficiency has already been made in the past, there is always some further step - a new machine or an improvement

/in organization

in organization - that will result in better performance. With more and more mechanization, using the latest equipment, and better organization to utilize men and equipment to the best advantage, more efficient performance is possible.

The railways in the region are fully alive to the necessity of introducing improved methods in track maintenance and, from the information available, are striving to quicken the evolution of the forces, towards higher efficiency. Steps to this end are taken every day and if there is a coordinated effort in this direction, the rate of progress will naturally be accelerated.

In connection with the introduction of bigger gangs with longer lengths some of the engineers of the region opine that, still, track maintenance without section gang, is "way ahead of the times," and therefore the railways of this region should go slow in this process.

Grouping of gangmen into long distance gangs would generally lead to greater efficiency and economy, provided (1) the mate is good and efficient, (2) the gang is located at a station where it can be easily contacted, (3) high-speed and unimpeded transport is available at all times, (4) the track is in normal conditions without many weak spots, and (5) the gang has modern equipment. From the social point of view, grouping of staff into long distance gang is recommended, as it provides better amenities to the gangmen by locating them at larger stations.

Other methods adopted by some railways to increase both the output and the quality of work of the gangmen are:-

1) Award of prize money,

2) Payment of premium,

3) Award of certificates and shields.

Prize money. Some railways award cash prizes to the gang whose output has consistently been good for a fixed period. While judging the work the following items of work are taken into consideration: alignment, level,

/surface,

surface, running condition, tightness of fittings, condition of drains, cleaning and trimming the bank and cutting, absence of weed from ballast, cleanliness of ballast and general condition of the track.

The prize money thus given is distributed among the mate, the key-man and the gangmen.

Premium. Each gang receives marks on periodical inspections which take into consideration the output of work and its quality and the behaviour of track for a given period. Some railways also give additional marks for both quality and quantity of the output. The premium allowed varies from 5 to 10 per cent of the wage of each individual gangman. Some of the Railways also pay an extra amount to a maximum of 15 per cent of the wage to individual gangmen for consistently good work for a long period.

It is claimed that the above measures besides improving the quality of work, have resulted in an increased output by about 30 per cent.

Certificates and Shields, are also awarded by some railways to the best gangs. Experience has shown that money awards achieve better results.

(iv) Railway Signs

It will be of great value if there is a uniformity of railway signs used in the region. Care will have to be taken to choose them properly. They should be of specific design, shape, dimensions, sizes, background colour of the board, and colour of lettering (there should be sharp contrast between these two for easy identification and legibility), location of the boards and materials from which the boards are to be made e.g. - wood, metal or concrete. The railway signs will be for:-

1) Defining railway limits and warning against trespassing;

2) Location signs, mile posts, curves, grades, limits of jurisdiction of various railway officials, boundaries of sub-divisions, districts and provinces, etc.;

3) Beats of permanent way gang;

/4) Name and

4) Name and number of bridges and tunnels;

5) Transportation signs, e.g., speed restriction (permanent and temporary), whistling posts, level crossings, warning to drivers of heavy grade or other special features, speed limits, yard limits;

6) Junction stations' and other stations' name boards etc.;

7) Safety signs, e.g., high voltage signs, fire risk signs.

/V. MODERN EQUIPMENT

V. MODERN EQUIPMENT

A very large number of modern equipment and power plants have been introduced on European and American railways with varying degrees of success. Modern equipment is being utilized for all types of work connected with the construction and maintenance of the railway track. Some of them are enumerated below. A short description is also given of those which are of specialized type. These include cranes, draglines, air compressors, electric generators, mowing machines, automobile trucks, tractors and variety of grading and ditching equipment, jacks, mechanical saws and drillers, ballasting cleaning and surfacing machine, power sleeper tamping equipment machine, uniform sleeper adzer (for accurate work), bull-clam shovel, high-lift shovel, overhead shovel, air dump cars, spreader cars, caterpillar tractors with angle dozer, shovels, composite machines, such as, spreader, ditcher, ballast plough, ballast and road-bed shaper, snow plough and ice cutter, power rail layers, power adzing and boring machines, power rail grinders (surface), power gauging machine, rail joint welding machine, flaw detector cars, ultrasonic detectors to locate the defects in rail (flaws can be detected before the failure actually occurs).

(i) Equipment for ballast

Gyratory crusher, jaw crusher, disc crusher, roll crusher, rotor impact crusher etc.

(a) Ballast washing plant. In this connection are used spreader car (removal of materials from ballast shoulder and using it for widening banks), wing dozer (cutting out and shaping ballast shoulder), crible-cleaning machine (removes foul ballast, separates dirt and disperses it, returning clean ballast to the crib shoulder). There are various other machines for loosening and removing dirty ballast, cleaning it and replacing it, such as, hopper trucks of various designs for distribution of ballast with one side, both sides, centre, and all three discharging, both hand and power operated.

/(b) McWilliams

(b) McWilliams cribbing machine for digging, removing and replacing ballast in passenger platform lines and station yard for better maintenance and improved drainage.

(c) McWilliams ballast distributor, a truck-mounted machine for placing ballast in position for tamping. It picks up ballast from intertrack space or shoulder by means of two conveyors mounted on either side of the machine and deposit it in correct position for tamping both inside and outside rail - operated by one man - operating speed of ballast distribution 800 ft. to 1,000 ft. per hour - travelling speed 18 m.p.h.

(d) Road bed stabilization - for soft road bed - water pockets - repairs to slides, and erosion - riprap.

(e) Matisa ballast tamper. This machine is driven and controlled by one man when tamping or when travelling to and from the working site. The two tamping heads are mounted between the wheelbase of the machine over each running rail, vertical penetration and withdrawal to and from the ballast bed being controlled by the compressor air circuit. The 16 spearheaded tamping tools transmit high frequency vibrations and a compressive action to the ballast, jockeying and settling each unit of the ballast into a final position under the sleeper and providing a firm, permanent and uniformly consolidated bearing area under each rail. Grouping the tools in relation to the rails eliminates all risks of hard bearing on the centre or at the extreme ends of the sleepers. Depth of penetration of the tamping tools is controlled so that compressive action jostles and forces the ballast particles directly into the voids immediately beneath the sleepers, while intense low amplitude vibration causes a settlement of the ballast throughout its depth into a compact but resilient support for the structure.

In actual working, the machine is normally preceded by a levelling gang. A single tamping cycle of 12 to 15 seconds per sleeper ensures perfect consolidation. All types of sleepers, e.g. wood, iron, steel, or concrete, and all classes of ballast consisting of crushed rock, stone, slag, ash, gravel or sand are within the scope of this tamping machine.

/(ii) Track shifting

(ii) Track shifting machines

(a) These consist of sleeper tamper (single or multiple), clay digger, backfill tamper, paving breaker, rock drill, worked electrically or pneumatically. Two railways have developed track sweepers (car-mounted vacuum cleaners).

(b) Use of oxyacetylene and electric welding equipment for welding or rebuilding rail ends have extended the service life of some of the elements of the track appreciably, resulting in large economies in track maintenance.

(c) The Detroit Toledo and Ironton use a 1952 model Pullman - standard power Ballaster to surface track. Lift jacks are spaced 6' apart under the rail to raise the track ½" to 2" with stone ballast. Jacks are placed opposite each other to minimize possibility of throwing track out of alignment in lifting. Twenty labourers work in a six-hour day, 3,500 to 4,000 ft. of finished track. Tamping bars 5/8" x 3¼" nearest rail and 5/8" x 2" are used for packing the track.

(iii) Detection of flaws in rails

After five years of intensive research, Dr. Elmer A. Sperry developed an apparatus to detect fissures for immediate replacement of the rail. Sperry detector cars were built. In addition, other types have also since been developed. The principle is that a current of about 3,000 amp. is passed through the rail at low voltage, thereby setting up a magnetic field about the rail head by means of which the axis of the field is changed and the flux becomes distorted whenever an internal flaw is encountered. This detector can also pick up the distortion by means of a coil which is passed along the head of the rail by proper amplification, actuates a recording apparatus, which records the location of defects on a paper tape while a paint gun indicates individual defects by projecting small daubs of paint upon the web of the rail directly opposite their locations in the head of the rail. In addition to transverse fissures, the detector car also detects split heads, piped rails, horizontal and compound fissures together with surface flaws and burned spots.

/This can detect

This can detect all flaws which include other defects in rails (flowed head - metal flows in lips overhanging head of rail); corrugated rails, weeping cracks (metal fatigue cracks) at end of rails. Burnt rails (due to skidding of engine).

(iv) Dun-Rite gauging machine (built in 1951)

It rides one rail on a flanged dolly contoured to the rail head. A gliding shoe or runner, adjusted to the exact width of the base of the rail being laid, glides along the rail seats of the distributed new sleepers, bringing them to a line which produces exact gauge of the running rail. This machine carries a multiple wood drill, driven by a gasoline engine, for boring holes simultaneously for two anchor spikes by inserting the bits through the anchor spike holes of the sleepers. The gauging machine is preceded by a sliding template by means of which the gauge plates are placed in approximate alignment. In its original form on the Nickel Plate, the gauging machine also carries a spike hammer for driving anchor cut spikes and an air compressor driven by a gasoline engine.

Subsequent improvements made in the machine have included the removal of the spike hammer, air compressor and engine with the result that the weight of the machine has been substantially reduced, while its mobility has been increased. Also, a detachable side frame with wheels has been developed for the glider side to permit the machine to be run along both rails to and from the job. When the glider is used, this side frame is detached and placed on outrigger arms on the side of the machine where it serves as a counterweight. The gliding shoe has been equipped with rollers, so that it becomes unnecessary to daub grease ahead of the machine on the rail seats of the sleepers, as was previously necessary to reduce friction. Also, the glider is so constructed as to be adjustable to various rail base widths.

General

Weed killer sprayer using either sodium chlorate or calcium chloride, either by manual or mechanical spraying, such as ESTERON Brush Killer are being used.

In some territories, detector fences and signals have been provided, which give alarm when bridge sleepers catch fire.

/ VI. GENERAL REMARKS

VI. GENERAL REMARKS AND RECOMMENDATIONS

Every business concern has for its efficient operation consistently to struggle to keep the level of its income in a proper balance with its operating expenses which, in the case of the railway, would largely depend on variable expenses, such as, cost of labour, materials and fuel. Today if railway finds itself in difficulties in keeping the proper balance as enumerated above, it should not consider itself alone in such a predicament as most of the industries at present are having similar worries. Railway problems, however, are more difficult as fixing of rates and fares is controlled by the government.

There is no doubt that the railways of the region will continue solving their current and future problems as in the past they had surmounted similar difficulties in the wake of the first World War. Engineers and technicians of the railways of the region will rise to the occasion and will adopt modern methods, ways and means, gradually, as suited to their needs, keeping in view the local conditions and achieving higher standard of service and better standard of maintenance with lesser maintenance cost.

In the history of railways of the world, there never was a time when more improvement in methods, standards, devices and highly advanced equipment were available for incorporation into railway operations than now.

Concerning most of the countries of the region, it may be said that perhaps there never was a generation of men who were so willing to strive to their utmost, inspired by the recently gained freedom, to utilize every possible opportunity and help to improve technical standards of their country in every sphere of life. This, certainly, is a happy augury, and if properly planned, should definitely ensure very good results.

The following would help to achieve efficient and cheaper maintenance of track:

/ 1. Better planning

1. Better planning and programming of maintenance work;
2. Improved supervision, initial and subsequently periodical training of mates, mistries, sub-inspectors and inspectors;
3. More stabilized programme of work connected with the track year to year, such as, overhaul, resleepering, relaying, complete track renewals, renewal of points and crossings, improvement to bank etc.;
4. Campaign against wastage of materials;
5. Collection and disposal of surplus and scattered materials;
6. Healthy competition between gangs; payment of prize money or bonus to gangmen for better output of work;
7. Ensuring adequate rest and amenities to the gangmen;
8. Closest possible cooperation with mechanical and transportation departments, so that maximum continuous time could be given, when required, for track work;
9. It would also help the operating department, if works close to each other are grouped and undertaken simultaneously;
10. "Safety first" education among gangmen;
11. Reduction of unnecessary office and routine work in the preparation of numerous forms and returns, thereby leaving more time for the permanent way staff to devote to the track maintenance;
12. Ensuring timely supply and distribution of materials for track works;
13. Ensuring adequate supply of tools. Unserviceable or worn-out tools should be replaced frequently;
14. Introduction of better and more durable tools. Considerable research has been carried out in Europe and America for improving the quality and durability of hand tools;

/15. Where possible

15. Where possible and economical, introduction of modern power tools and plants, (both off and on the track types);

16. Efficient means of transport for the supervisory staff;

17. Provision of gang huts, more or less in the middle of their section to avoid gangmen walking long distances before starting work. Gangmen should be discouraged to live away from their work;

18. Supervisory staff should be impressed with the desirability of remaining with gangs for long periods, guiding them in the maintenance works;

19. Supervisory staff should be discouraged to trolley long distances on any day, as this will reduce time spent by them with the gangs;

20. It would increase efficiency, if the gangs are given short talks by the supervisors with cinema slides or films on track maintenance from time to time.

Improvement to track could be achieved by:

1. Use of longer sleepers;

2. Greater density of sleepers;

3. Good quality and quantity of ballast, hard, angular in shape and free from dust;

4. Heavier section of rails;

5. Better holding of rails to sleepers and prevention of creep;

6. Stabilization of formation;

7. Use of continuously welded rails;

8. Cleaning of ballast when required;

9. Thorough through packing, periodically;

10. Widening of embankment, where necessary;

11. Improvement to drainage where drainage is bad.

/Further reduction

Further reduction in cost of maintenance could be made by:

1. More careful planning of the work;
2. Improved supervision;
3. Use of mechanical equipment suitable for local conditions to offset increased wages of labour;
4. Welding the joints at level crossings, tunnels, over poor formation, large bridges, viaducts, platform lines and near water columns etc., which will decrease the cost of maintenance at these places;
5. Continuous study as such for more permanent and longer life of materials and tools;
6. Selection of better men for supervisory and maintenance jobs and giving them good and periodical training;
7. Continuous search to find means for reducing maintenance cost.

The above measures are all the more necessary as the Railways in future years will be required to render the kind of service that will attract traffic and at rates that will procure it, while, at the same time, paying high wages to the staff.

In the field of research, experimentation, coordination and standardization for the betterment of track maintenance, both Indian Railway Conference Association, and Central Standard Office of the Railway Board, India, had been doing very useful work in the pre-war period. A short time ago, it is reported, the Railways in India have set up a 'Railway Research Centre' at Lucknow for the research work on railway mechanical and civil engineering.

In conclusion; it is reiterated that it will improve the standards of Construction and maintenance of Railway track if special attention is paid to the following:

/1. Training of

1. Training of supervisory staff in permanent way construction and maintenance;

2. For the lower grade supervisory staff, there is a great need for increasing facilities for periodically training in railway schools of mates, mistries and sub-inspectors;

3. For the engineers, organizing a training centre where they could learn most efficient methods of maintenance, both with manual and mechanical appliances, the very awareness of which may greatly facilitate their planning and programming to introduce in a balanced and gradual way modern track maintenance methods, keeping in view the cost of labour, suitability of mechanical tools and plants, capacity of local talent to handle them and economy etc.;

4. The countries of the region should also take advantage of fellowships and scholarships for sending their senior engineers out for training. It would, indeed, be of great advantage if the senior railway engineers of the region visited railways of advanced countries to inspect actual operations in order to learn what other railways are doing, and how they are doing. This is a healthy way of obtaining additional knowledge, which they could put to use on their home railways with tangible benefits in the form of reduced maintenance costs and increased efficiency. In other words, they will be finding out first-hand what more advanced railways are doing and how they are adapting superior practices: mechanical tools and plants, also their cost, the countries where they are produced, the advantages and disadvantages in their use etc. Unless they are intimately acquainted with the operation of modern appliances, they could not with advantage adopt them in their own countries when the time comes. Furthermore, they will be able to obtain information regarding cost of equipment in comparison with the labour it replaces, and the best type of machine for each class of

/work.

work. They will also be able to find out details of their replacement, preventive maintenance, minimum strength of labour required for the maintenance of equipment, life of equipment, etc., etc.

While introducing modern mechanical methods, one has to take into consideration the following:

1. Where labour is cheap mechanical methods may be more costly;
2. Initial expenses and maintenance cost of mechanical tools and plants;
3. Availability of personnel required for operating mechanical tools and plants;
4. Training of personnel for operating mechanical tools and plants;
5. Once labour gets accustomed to mechanical tools, they will be less willing to work manually later;
6. Mechanization may increase unemployment;
7. Unless big gangs with longer lengths are introduced, it may not be economical to equip each gang with mechanical tools;
8. There should be adequate plant maintenance organization;
9. For single-line track, it is not economical to use tools and plants of any other type except off-track equipment.

It is hoped that the Railways Sub-Committee will indicate a few of the above topics on which the Secretariat might usefully concentrate its attention.